Chemistry Quiz
Quantitative Relationships in Chemical Reactions
Instructor's Version

Answers to Section I (Multiple Choice)

1.	**E**
2.	**C**
3.	**B**
4.	**D**
5.	**E**
6.	**E**
7.	**A**
8.	**C**
9.	**A**
10.	**B**

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Answers to Section II (Free Response)
Time Limit: You have 30 minutes to complete this section.
Scoring: 60 points total; question 1 is worth 30 points and question 2 is worth 30 points; points for each section are indicated within the question.
Calculator: You may use a calculator for both of these questions.

1. Copper metal is easily oxidized to Cu^{2+} by nitric acid according to the following equation:

$3\ Cu\ (s) + 8\ HNO_3\ (aq) \rightarrow 3\ Cu(NO_3)_2\ (aq) + 2\ NO\ (g) + 4\ H_2O\ (l)$

A copper penny with a mass of 3.067 g is dissolved in 100.0 ml of 1.000 M nitric acid.

A. How many moles of copper are in the penny, assuming it is pure copper? (10 points)

Answer:

$$3.067\ g\,Cu\left(\frac{1\,mole}{63.546\,g}\right) = 0.04826\ moles\ Cu$$

Points: 3 points, correct atomic weight; 3 points: mass/atomic weight; 3 points, correct answer, 1 point for 4 significant figures in answer

B. When the reaction stops, the undissolved penny is removed. What is the mass of the undissolved penny? (12 points)

Answer:

moles Cu reacted = (0.1000 L HNO_3) $\left(\frac{1.000\ \ moles}{L}\right)\left(\frac{3\,moles\ Cu}{8\,moles\,HNO3}\right)$ = 0.03750 moles Cu

moles Cu remaining = 0.04826 moles initially - 0.03750 moles reacted = 0.01076 moles Cu

$$mass\ Cu\ remaining = 0.01076\ moles\,Cu\left(\frac{63.546\,g\,Cu}{mole\,Cu}\right) = 0.6838\ g\ Cu$$

Points: 4 points, correct set-up for moles Cu reacted; 2 points, correct calculation of moles Cu remaining; 3 points, correct set-up for mass Cu remaining; 2 points, correct answer, 1 point, 4 sig figures

C. The solution prepared in step B is transferred quantitatively to a 250.00 ml volumetric and diluted to the line. What is the molarity of the Cu^{2+} in this solution? (8 points)

Answer:
moles Cu reacted = 0.03750 (from step B)

$$concentration\ of\ Cu\ in\ solution = \left(\frac{0.03750\,moles\,Cu}{0.25000\,L}\right) = 0.1500\ M$$

Points: 3 points, correct use of moles Cu reacted (from step B); 3 points, correct calculation of molarity; 1 point, correct answer; 1 point, correct # sig figures

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2. A precipitate forms when 100.00 ml of 0.100 M sodium chloride is mixed with 50.00 ml of 0.100 M silver nitrate.

A. Identify the precipitate and write a net ionic equation that accounts for its formation. (6 points).

Answer:
Precipitate must be silver chloride (AgCl) since sodium nitrate ($NaNO_3$) is soluble.

$$Ag^+ (aq) + Cl^- (aq) \rightarrow AgCl (s)$$

Points: 2 points, identification of precipitate; 3 points, correct net ionic equation for formation (NO SPECTATOR IONS); 1 point, indication of forms of substances (aq vs s)

B. What is the mass of the precipitate that forms in this reaction? (12 points)

Answer:
moles Cl^- used = 0.10000 L(0.100 moles/L) = 0.0100 ---> 0.0100 moles precipitate
moles Ag^+ used = 0.05000 L(0.100 moles/L) = 0.00500 ---> 0.00500 moles precipitate

Ag^+ is therefore limiting and governs amt of ppt actually obtained: 0.00500 moles AgCl

0.00500 moles AgCl(143.3212 g/mole) = 0.717 g AgCl

Points: 4 points, correct calculation of moles of precipitate formed; 4 points, recognition of limiting reagent; 3 points, calculation of mass of precipitate; 1 point, correct significant figures

C. What is the molar concentration of each of the dissolved (aqueous) ions when the reaction is complete? (12 points)

Answer:
Note that this is essentially a dilution problem; V_{final} = 150 ml and $V_{initial}$ varies.
$[Na^+]$ = **0.0667 M** $\frac{0.10000\ L(0.100\ moles/L)}{0.15000\ L} = 0.06667\ M$

$[Cl^-]$ = **0.0333 M** 0.0100 moles init. - 0.0500 moles precipitated = 0.00500 moles left
(0.00500 moles in solution)/0.15000 L final volume = 0.0333 M

$[Ag^+]$ = **0 M** ***(precipitates completely as AgCl)***

$[NO_3^-]$ = **0.0333 M** init. moles (same as Ag+) = 0.0500 ---> conc. = 0.0333 M (see calc for Na^+)

Points: 3 points each; For other than Ag^+: correct # init. moles = 1 pt;correct use of final volume = 1 pt; correct setup and answer = 1 pt. 1 pt deduction overall for sig fig. Ag^+ calculation: -3 if any answer other than 0 is give

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